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Aerial census of grey seal (Halichoerus grypus Fabricus) pups in Iceland in 1982

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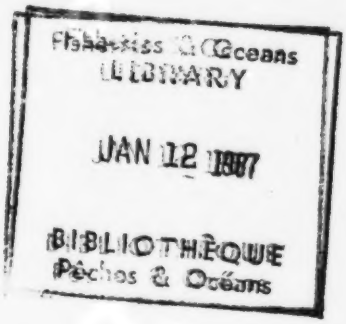

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AERIAL CENSUS OF GREY SEAL (Halichoerus grypus Fabricius) PUPS IN ICELAND IN 1982

Erlingur Hauksson

AERIAL CENSUS OF GREY SEAL (HALICHOERUS GRYPUS FABRICIUS) PUPS IN ICELAND IN 1982

Introduction

An aerial seal survey in the summer of 1980 (Erlingur Hauksson, 1985) revealed that direct counting of mature grey seals (Halichoerus grypus) involves many problems. These problems have made it impossible to make accurate grey seal population assessments in Iceland. It was found that when mature grey seals were counted from a plane, the result would always be too low, and the same would be the case if the total Icelandic grey seal population was estimated from these findings. However, it was also concluded that direct aerial counts of common seals (Phoca vitulina) would provide better results.

The objective of surveying grey seal pups in the fall of 1982 was to improve this situation; to use the results to provide a valid estimate of the size and condition of the grey seal population around Iceland.

In Great Britain, research on grey seal has shown that rather than attempt to count all seals, a much better assessment of the seal population can be obtained by counting pups at the height of the breeding period, estimating the total number of pups that will be born, and then assessing the total number of mature seals from these findings. This method is

used when the number of newborn grey seal pups is calculated and when assessments are made of the size of the British grey seal population (Summers, 1978; Anon, 1982).

Previous attempts to estimate the size of the grey seal population around Iceland include: Teitur Arnlaugsson (1973), Solmundur Einarsson (1978) and Erlingur Hauksson (1980). The two first named authors used information they had from pup hunting, while I used myself direct aerial counts. This is the first study that, therefore, estimates the grey seal population by counting pups from the air.

METHODS

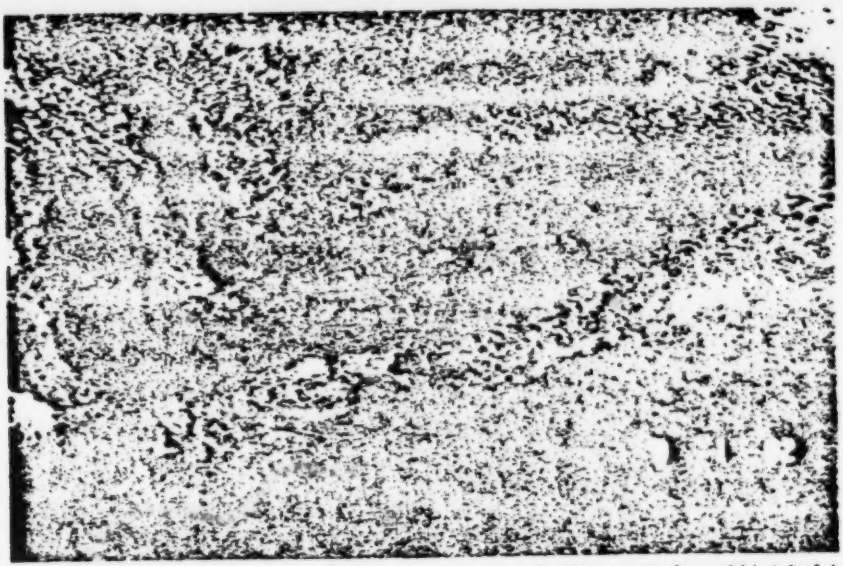
Counting seals and analyzing the data

The seals were counted from the air in the period October 8th to November 1st 1982. The airplanes used were Cessnas with the Icelandic registration letters TF-SKM and TF-FTG, two-man high-wing aircrafts. The grey seal pups were counted directly from the air as the plane flew over them. However, if their numbers were too great to be easily counted, pictures were taken and later analyzed with a scanner (fig. 1). An 8 by 16 enlargement was used and the seals counted through a lens with chequered lines. The camera was a "Canon AE-1 Program" 35 mm with a 70-150 mm zoom lens, autowind and a "data-back" system that automatically identifies each picture. The pictures were taken at the speed 1/250 of a second or faster according

to light conditions at the time of the counts. The film type "EL 135-36" was used. The total number of hours in flight used for the census were 46. The plane usually flew at an altitude of 150-300 meters at slow speed when searching for pups. However, when the pups were being counted the plane flew lower and as slowly as was possible.

The coastal sites examined where those where it was known, either for sure or thought likely, that grey seals used them as breeding grounds. The whole of Faxafloi bay (West Iceland, comm. transl.) was examined, (as were) Breidafjordur bay (West Iceland, comm. transl.), the West Fjords (Northwest Iceland, comm. transl.) and Strandir (Northwest Iceland, comm. transl.) all the way east to Skagafjordur fjord (North Iceland, comm. transl.). The south coast of Iceland was also examined all the way from Reykjanes (Southwest Iceland, comm. transl.) to Eystra-Horn (Southeast Iceland, comm. transl.), along with the islands Vestmannaeyjar, Eldey and Surtsey (South Iceland, comm. transl.). The Ausfirdir fjords (which cover the whole of the east coast of Iceland, comm. transl.) were also examined south of the island Papey (Southeast Iceland, comm. transl.). However, the area extending from Papey island north through Langanes peninsula (Northeast Iceland, comm. transl.) and west into Skagafjordur fjord (Northwest Iceland, comm. transl.) was left out. Also, certain coastal areas within each of the examined regions were left out as it was known for certain, that grey seals did not breed there. This applied, for

example, to river deltas in South Iceland, and the innermost part of Vestfirdir fjords (Northwest Iceland, comm. transl.). The most important areas known to include grey seal breeding sites but not examined in this study were Hvalbakur and Manareyjar islands (North Iceland, comm. transl.). It is believed that grey seals have recently started breeding in Manareyjar islands. The coast was divided into areas in order to make it easier to analyze the data, and the numbers of pups in each area were added up. Following this, the total numbers of pups in all areas were added up.



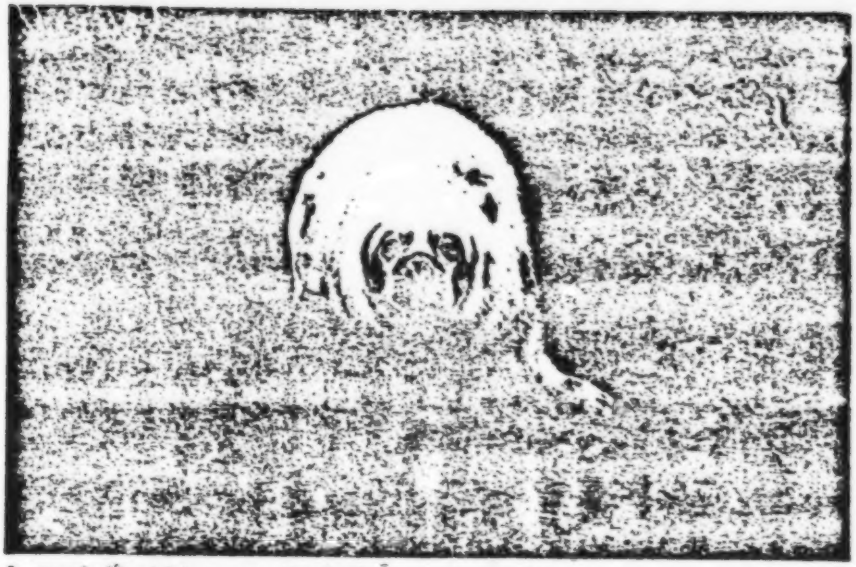
1. mynd. Flest útselalátur eru í fjörunni í eyjum og skerjum, sem fara ekki á kaf í stórstreymi. Útselskópar í Hvalseyjum við Mýrar. – *Most breeding places of grey seals at the coast Iceland are on islands and skerries, which do not get submerged during high tide. Grey seal pups in Hvalseyjar, Mýrar (at the west-coast of Iceland).* (Ljósm./*photogr. by* Erlingur Hauksson).

Fig. 1. - Most breeding places of grey seals at the coast of Iceland are on islands and offshore rocks that do not get submerged during high tide. Grey seal pups in Hvalseyjar islands, Myrar area (West Iceland). Photogr. by Erlingur Hauksson).

Estimating pup production

Three factors must be taken into account when estimates of the number of newborn grey seal pups are made from aerial surveys. *First* it must be taken into account that not all the pups can be seen from a plane. A number of pups are hidden behind cliffs, large rocks and vegetation, or submerged in

ponds on the beach near the sea (fig. 2). The proportion of pups seen from the air out of the actual pup population must be found (this will be termed correction factor R). At the "same time" as the aerial survey, a survey from ashore must be performed covering the same area. The actual numbers of pups hauling out in an area (Y) can be calculated from the numbers counted in an aerial survey (X) if R is known, as Y=RX (Eberhardt et. al., 1979). The R factor has been calculated in this study by comparing information from seal hunters that hunted in certain islands just after an aerial count was made (fig. 1). The correction factor R has also been calculated for seals in the British Isles (Vaughan, 1971; Bonner, 1976). The R was found to be 1.05 (95% confidence interval 1.03-1.07). For correcting the number of pups counted during an aerial survey this study also uses R as 1.05, the same as the British studies. The reason why the same value is used here as in Britain, is that British studies on this matter are more numerous than Icelandic ones. Icelandic values found for R, shown in table 1, do also not reveal statistically different results from the British value.



2. mynd. Útselskópar eru óburðugir fyrst eftir kæpingu, en braggast fljótt á móðurmjólkinni og fitna mjög. Stálpaður útselskópur, sem hefur gránað í vöngum og á hreifum. – *A grey seal pup at a typical breeding site in Iceland.* (Ljósm./*photogr. by* Erlingur Hauksson).

Fig. 2. Grey seal pups look frail just after birth, but from their mothers milk they mature quickly and get fatter. The picture is of a grey seal pup that shows signs of maturity.

Secondly, it must be taken into account how the timing of the survey relates to the high point of the breeding period; the time at which the greatest numbers of seals haul-out. This involves a number of difficulties, as the high point of breeding period frequently differs between breeding sites. Differences even exist within fairly well closed-off areas,

like Breidafjordur bay (West Iceland, comm. transl.). Therefore it is necessary to always perform the surveys at the high point of the breeding period at each site.

This is more advisable than using the method of surveying newborn pups hauling-out at dates outside the high point of the breeding period and then attempting to multiply this number with a correction factor based on how far the survey date is from the high point of the breeding period. Information on the high point of the breeding period in each area can be obtained by observing seal breeding at selected spots along the coast. In this study it is taken as given that the aerial surveys were always performed at the high point of the breeding period at each site. No attempts will be made to correct the findings for "time from high point of breeding period".

The *third* matter of concern is that the breeding period of grey seals can extend over a substantial period of time. Despite that "high point of breeding period" is used here to estimate the greatest number of pups hauling out at each site, this "greatest number" can only serve as an indirect indicator for assessing the total number of pups born in a specific area.

Some pups have at the "high point of breeding period" already left the breeding grounds and others are still unborn. It is therefore necessary to multiply the greatest number of pups hauling out (N_{kmax}) with the correction factor (ŏ) to find the maximum pup production during the breeding period (P_k). This is shown below

$$P_k = ŏ \times N_{kmax}$$

For the purpose of obtaining the factor ŏ (which is the proportion between pup production and the maximum number of pups hauling-out), the progress of pup breeding in selected areas must be followed. This has been done in the British Isles (Hilby and Harwood, 1979). The ŏ factor was found to be in the range 1.15 - 1.72, with a statistically significant non-random difference existing between years. However, a statistically significant difference was not found between areas. The average of the ŏ values is 1.38 (95% confidence interval 1.34-1.42).

The relationship between pup production and the maximum number of pups hauling-out has not been examined for the Icelandic grey seal population, although an attempt was made to do this in 1981. However, estimates of pup production in an area can be made by examining information on pup hunting in islands where hunters went more than once to each area. Table 2 provides information on this for a few islands in the Hergilseyjarlond area in Breidafjordur bay. The values range

from 1.13 to 1.79, with an average of 1.38 (95% confidence interval 1.11-1.65). A statistically significant difference does not exist between this average and the average found in the British Isles (t-test $p>0.9$). When determining the pup production of grey seals in the fall of 1982, the number of pups ashore is, therefore, multiplied with 1.38.

A number of islands had been visited for pup hunting before seals were counted there. The findings of the aerial survey must be corrected for this. This involves adding the number of pups killed to the number of pups counted ashore from the air and then correcting with factor R (by multiplying with 1.05).

Table 1.
Comparison of counts of grey seal pups made on land and from the air, in the same area in 1982.

Area	Counts from air		Counts on land		Correction factor
	Day	Numbers(x)	Day	Numbers	R=y/x
Selected islands in Hergilseyjarlond (Breidafjordur bay)	Oct.12	47	Oct.13-14	49*	1.04
Islands at Hafnir at Skagi (Northwest Icel.)	Nov.1	75	Nov.6	77**	1.03

* Mr.Hafsteinn Gudmundsson, from Flatey island (Breidafjordur bay, comm. transl.), pers. comm.

** Mr. Jon Benediktsson, from the farm called Hafnir in the Skagi area (Northwest Iceland, comm. transl.), pers. comm.

Estimating population size from pup production

Studies of the relationship between population size and pup production show that for grey seal populations that are expanding, the proportion between pup production and total population varies between 3.5 and 4.5 (Harwood and Prime, 1978). The factor 4 is used for estimating the grey seal population in Iceland from estimated pup production. The factors 3.5 and 4.5 are used to find the lower and higher limits of the population and these findings are also corrected in relation to the 95% confidence interval R (1.05) and Ö (1.38).

RESULTS

The size of haul-out sites and their location along the coast

The grey seal haul-out sites around Iceland differ considerably in terms of size; they include from from one pup to a few hundred. As an example, there existed in the fall of 1982, 294 pups on Svinafells and Skaftafells beaches (South Iceland, comm. transl.), 235 pups at Tharalatursnes peninsula at Strandir (Northwest Iceland, comm. transl.) and 193 in Hvalseyjar (West Iceland, comm. transl.) (fig. 3). On the average 33 pups existed at a haul-out site. Breidafjordur bay has the greatest number of haul-out sites (table 3). A total of 870 pups were observed there.

Table 2. Catch of grey seal pups in some islands in Hergilseyjar in Breidafjordur bay in the autumn of 1982. Based on pers. comm. with Mr. Hafsteinn Gudmundsson.

Tafla 2. Útselskópaveiði í nokkrum eyjum í Hergilseyjarlöndum, Breiðafirði haustið 1982. Farnar voru tvær yfirferðir í eyjarnar. Upplýsingar frá Hafsteini Guðmundssyni í Flatey.

– Catch of grey seal pups in some islands in Hergilseyjar Breiðafiord in the autumn of 1982. Based on pers. comm. with Mr. Hafsteinn Guðmundsson.

Veiðistaður *Locality*	Veiðitími *Hunting dates* Fyrri yfirferð *First time*	Seinni yfirferð *Second time*	Kópaveiði *Catch of pups* Fyrri yfirferð *First time* (n_1)	Seinni yfirferð *Second time* (n_2)	Samtals *Total* ($N=n_1+n_2$)	θ^* (N/n_1)
Oddbjarnarsker	9. okt.	2. nóv.	58	46	104	1,79
Oddleifsey	13. okt.	4. nóv.	25	15	40	1,60
Reykey	13. okt.	4. nóv.	4	1	5	1,25
Sandey	14. okt.	6. nóv.	5	1	6	1,20
Áskelsey	14. okt.	6. nóv.	8	1	9	1,13
Æðarsker	14. okt.	4. nóv.	16	5	21	1,31
Meðaltal/*Mean*						1,38
95% öryggismörk/*95% confidence interval*						1,11–1,65

* Mat á hlutfallinu kópaframleiðsla / fjöldi kópa á landi.
Estimate of the proportion: pup production / maximum number of pups on land .

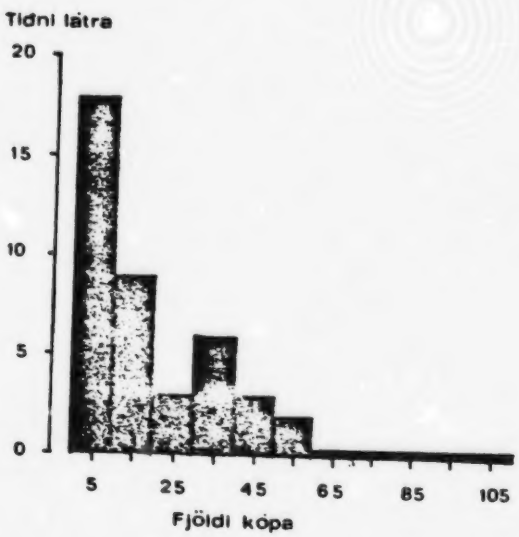
Table 3.

Tafla 3. Fjöldi útselskópa á kæpingarstöðum útsels við strendur Íslands, haustið 1982.
Numbers of grey seal pups on the breeding-places at the coast of Iceland, in the autumn of 1982.

Strandsvæði *Coastal area*	Fjöldi kópa, séð úr lofti *Numbers of pups seen from the air*	Leiðréttur fjöldi kópa m.t.t. vantalningar og veiði f. talningardag *Corrected numbers**	Kópaframleiðsla *Pup production*
Faxaflói	248	261	365
Breiðafjörður	484	870	1218
Strandir-Skagafjörður	396	416	583
Suðurströndin	297	350	490
Samtals/*total*	1425	1897	2656

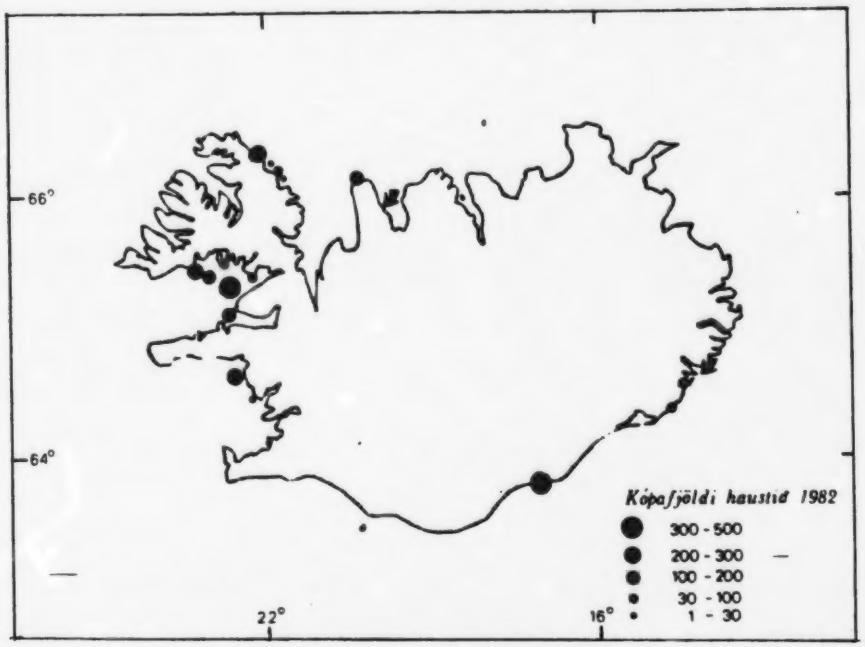
* *Corrected for undersampling and hunting prior to the day of census.*

Fig. 3.



3. mynd. Dreifing útselslátra eftir stærð (fjölda kópa) haustið 1982. Meðalfjöldi kópa í látri er 33 og miðgildið 14. – *Distribution by size of the breeding places of grey seals at the coast of Iceland, in the autumn of 1982. Mean numbers of pups per breeding locality is 33 and the mode is 14.* Tíðni: *frequency:* Fjöldi kópa: *number of pups.*

Fig. 4.



4. mynd. Dreifing útselslátra við ströndina haustið 1982. Fylltu hringirnir tákna kópafjölda. Það svæði sem ekki var talið á nær frá Skagafirði austur fyrir Langanes og suður í Berufjörð. Auk þess var Grímsey, Mánáreyjum og Hvalbak sleppt. – *Distribution of the breeding places of grey seals, at the coast in the autumn of 1982. The size of the dots indicate the numbers of pups seen. The counting area is between two arrows.*

In Breidafjordur bay the greatest number of pups existed in the Skardslond area, while the second largest number was found in Hergileyjarlond area. After this comes the coastal area Strandir to Skagfjordur fjord (Northwest Iceland, comm. transl.), with 416 pups. Smaller numbers existed in other coastal area. The area from Skagafjordur fjord through Langanes peninsula (Northeast Iceland, comm. transl.) to Berufjordur fjord (East Iceland, comm. transl.) was not thought to be worth searching at all, as apparently no seals breed there. The only possible exception could be, according to latest information, Manareyjar Islands (Northeast Iceland, comm. transl.). The distribution of grey seal haul-out sites and the number of pups by areas is shown in fig.4.

Time of breeding

It was decided to time the survey just before the middle of October, when the breeding period would be at its highest. This time was chosen after analyzing information from seal hunters and following findings of the author of this study from 1981. The 1981 study involved observing grey seal breeding in a few islands in Breidafjordur bay. It was discovered that the seals appear to breed sooner in the inner parts of the bay compared with the outer parts. Breeding was already well on its way at the beginning of October in the area Reykholalond. In that area breeding had finished at the beginning of November, and most of the pups had gone into the water. The same is to be

said about Olafseyjar islands. In contrast, breeding was still progressing at full speed in the area Hergilseyjarlond in this same period; on November 11th 1981, 40 grey seal pups were observed in Oddleifsey island (see also table 2).

At Strandir and Skagi (Northwest Iceland, comm. transl.), findings from a population survey indicate that breeding is at a high point around the end of October and beginning of November; only 40 grey seal pups were located in the Tharlatursnes area on October 12th, while in the second count on November 1st the number had gone up to 235. At Skagi the grey seal pup hunt has always been in the first week of November (Jon Benediktsson, farmer on the farm called "Hafnir" in the Skagi area, pers. comm). The high point of the seal breeding period around Southeast Iceland is probably limited to the first part of October. On October 9th 1982, 38 grey seal pups were caught in this area; in the island Vigur in Lonsvik inlet, and three days later 3 newly born pups were observed there.

The breeding period of grey seals extends over a considerable period, from September through February. Newborn grey seal pups have even been found at the haul-out sites in the month of March. The high point of the breeding period in Iceland appears, however, to be in the month of October; in the first part of the month in Faxafloi Bay (Southwest Iceland, comm. transl.) and along the southern and northeastern parts

of Breidafjordur bay (West Iceland, comm. transl.) and Southeast Iceland; but at the end of October in the northwestern parts of Breidafjordur bay and in the Strandir and Skagi areas (Northwest Iceland, comm. transl.).

Pup production and the size of the grey seal population

The total number of grey seal pups seen around Iceland during the aerial survey in the fall of 1982 totaled 1425. After correction both for the factor R and the pup hunt before the day of the survey, it is found that around 1900 pups hauled-out around the time when the survey was performed (table 3). According to these findings, pup production was around 2660 pups or in the range of 2050-3080 (when calculating the lower part of the range R=1.03 and ŏ=1.1 are the multipliers, while for estimating the upper limit of the range, R=1.06 and ŏ=1.7). For the production of 2660 pups 10600 mature animals are needed (4 times 2660). The lower limit of this grey seal population estimate is 7200 animals in Iceland, while the upper limit is 13900 (3.5 * 2050=7175 and 4.5 * 3080=13860).

CONCLUSIONS

According to research done in the British Isles, around 95% of pups that haul-out can be seen from land (Bonner, 1976). The most effeftive method of spotting the pups is to look directly down on to the beach, and also to take pictures straight down. When the angle of observation is decreased, there is a growing danger that part of the pups will not be seen. A comparison of

counting in the same area from the air and land in the fall of 1982 also showed that on the average 95% of pups can be observed from the air. More research needs to be done to examine this factor. It is hard to determine exactly if the number of pups will be estimated too high or too low by setting R as 1.05. However, it is clear that any deviation will be very small.

However, other and more important causes of faulty pup population estimates could be: First, an underestimate of the total number of pups at the time of a survey. The reasons for this could be that the people doing the counting miss pups lying alone on the beach, away from the main breeding site.

Secondly, dead pups are not easily spotted and disappear in the sand or in between rocks. Thirdly, the maximum number of pups hauling out is underestimated when only one aerial count is done in each breeding area, as it is unlikely that all areas were covered at exactly the time when the maximum number of pups hauled-out. For obtaining the best results on this matter, information on the progress of breeding at the most important haul-out sites in Iceland must be followed, and the aerial survey should then be performed when the greatest number of pups haul-out. Aerial surveys should also be performed more than once in the main breeding areas for the purpose of discovering the high point of the breeding period.

Fourth, it is uncertain if information has been obtained on all the pups hunted. However, it should be expected that the great majority of hunted pups have been reported after the start of bounty payments for seals in 1982.

For the purpose of determining pup production of grey seals from a seal count, the findings must be multiplied with ð. For estimating the size of the grey seal population in Iceland, ð was set at 1.38. This figure was found by using information from hunts in the Hergilseyjarlönd area in Breidafjordur bay. The factor may not be applicable to other grey seal breeding areas in Iceland. More research is needed on this matter and detailed information must be collected on the size of ð at other breeding sites. In comparison to research findings on grey seals in the British Isles, the ð may appear too high. However, this can only be clarified after ð has been found for each breeding site in Iceland.

Various difficulties exist in using pup production to determine the size of the grey seal population. However, this is the method that has provided some of the best results (See Erlingur Hauksson, 1985). If the size of the population is to be determined more exactly than has been done here, information must exist on the number of animals behind every pup born. Information on this is not available in the case of Icelandic grey seals. Therefore, the range 3.4 - 4.5 is used for

multiplying the number of pups born. This range is, however, right for a growing grey seal population (Harwood and Prime 1978). It can therefore be hard to say if 10,600 animals is an over- or underestimate, while it can be stated with confidence that the population is somewhere in the range mentioned; 7,200-13,900 seals.

Older methods of determining the grey seal population around Iceland have either involved counting the whole population or using information from seal hunts. In the summer of 1980 it was discovered that counting seals directly in the summertime was not appropriate for determining the size of the grey seal population; this method was always found to provide low figures that led to an underestimate of the size of the seal population (Erlingur Hauksson, 1985).

Another method that also involves a series of difficulties, is similar to a method described before: the seal population is estimated by finding the "number of mature seals behind each pup". Pup numbers are assessed from hunting reports. Information on the number of hunted pups is sparse for previous years and also unreliable. Hunting pups for their pelts has been uncommon or non-existent in the last years, while there has always been some pup hunt for food. However, pups hunted for food are frequently missing from hunting reports. The estimate of Teitur Arnlaugsson (1973) is therefore, as he points out himself, at the lower limit of the population.

Solmundur T.Einarsson (1978) was closer to the actual situation when he stated that the grey seal population in Iceland (1978) is around 8 - 10 thousand seals.

It is therefore hard to determine if, or how much, the grey seal population has grown in recent years. However, it is the common opinion of most of those who observe grey seals regularly, that the population is increasing. Seal hunters in Breidafjordur bay state that more pups existed there in the fall of 1982 than in the period 1960-1975 (Hafsteinn Gudmundsson, farmer in the island Flatey in Breidafjordur Bay, pers. comm.). In Drangavik inlet in the Strandir area (Northwest Iceland, comm. transl.), common seals were rarely seen in the first part of this century, while their numbers have increased since (Kristinn Jonsson, farmer at a farm called Drangar, pers. comm.). In Hafnir in the Skagi area (Northwest Iceland), few grey seals existed around 1940. However, according to my own research, a 300 seal haul-out site existed there in the summer of 1981, and on the average around 100 pups have been killed by hunters there in the last few years (Jon Benediktsson, farmer at a farm called Hafnir in the Skagi area, pers. comm., along with information on pup hunting in Hafnir in 1982). At Tharlatursnes peninsula in the Strandir area, grey seals were rarely seen around 20 years ago (Ragnar Jonsson, fisherman from Reykjafjordur, pers. comm.), while according to information in this study, a haul-out site exists there with more than 200 pups and a great number of mature seals. In the

fall of 1983, a 30 pup grey seal haul-out site was found in Jokulfirdir fjords in Isafjardardjup bay (Northwest Iceland, comm. transl.). Grey seals are not known to have bred there before (Ragnar Jakobsson, fisherman, pers. comm.).

This information appears as strong evidence in showing that the grey seal population is growing in Iceland and that the number of grey seals has increased along the coast of the country in the last decades. The explanation for this is possibly that hunting has decreased and favourable breeding sites have become more available for the seals, as people have moved away from isolated areas. Examples of this are the Hornstrandir area (Northwest Iceland, comm. transl.) and some of the islands in Breidafjordur Bay. It appears that there is further potential for increases in the grey seal population; more breeding areas are becoming available as people are still evacuating isolated areas of Iceland. Surveys on the distribution of grey seals in the British Isles imply that the most effective factor limiting the size of the grey seal population is the number (total square area) of usable breeding sites (Harwood and Prime, 1978).

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SUMMARY

Aerial census of grey seal (*Halichoerus grypus* Fabricius) pups in Iceland in 1982

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In the autumn of 1982, an aerial survey of grey seal pups, was carried out at breeding places around the coast of Iceland (fig. 1).

Breeding places were most numerous in Breiðafjörður, on the west coast of Iceland (fig. 4), and also there the grey seal pups were observed in the highest numbers (Table 3).

From the number of pups seen on land, corrected for undersampling and hunting of pups before the day of census, the pup production of the Icelandic grey seal stock is estimated to be 2660 pups (95% confidence interval 2050–3080). The size of the grey seal population is estimated as 10600 (4 times the pup production) animals of 1 year of age and older, with the possible range of 7200–13900 animals (3,5 and 4,5 times the lower and higher limit of the pup production).